

Having thus described the preferred embodiment, the invention is now claimed to be:

1. An assembly comprising:  
an x-ray tube (1) including:  
an envelope (14) which defines an evacuated chamber in which x-rays are generated (12);  
a housing (30) which surrounds at least a portion of the envelope;  
a cooling system (32, 32') which circulates a coolant through the housing to remove heat from the x-ray tube, the cooling system including:  
a pump(40, 40'); and  
a flow sensor system (60, 60') which is responsive to a pressure difference across the pump.
2. The assembly of claim 1, wherein the flow sensor system includes a differential pressure transducer (60, 60').
3. The assembly of claim 1, wherein the cooling system (32, 32') further includes:  
a recirculating fluid flow path (33, 33') including a first fluid line (34, 34') which connects the housing (30) with an upstream end of the pump (40, 40') and a second fluid line (50, 50' 36, 36') which connects a downstream end of the pump with the housing, the flow sensor system being responsive to a pressure difference between the first fluid line and the second fluid line.
4. The assembly of claim 1, wherein the flow sensor system detects a first pressure upstream of the pump and a second pressure downstream of the pump.
5. The assembly of claim 1, further including a processor (80, 80') which receives a signal from the flow sensor system correlated with the pressure difference, the processor determining a flow rate of cooling fluid therefrom.

6. The assembly of claim 5, further including:

a control means (81, 81' , 82, 82' , 107), the control means controlling operation of the x-ray tube in the event that the determined flow rate is below a preselected minimum level.

7. The assembly of claim 5, further including:

a control means (81, 81' , 82, 82' , 107) responsive to the pressure difference controlling at least one of:

operating power of the x-ray tube;

operating time of the x-ray tube;

selectable scan protocols; and

a cooling period prior to subsequent operating of the x-ray tube.

8. The assembly of claim 1, further including:

a temperature sensor (90, 92) which senses a temperature of circulating coolant in at least one of the housing and the cooling system.

9. The assembly of claim 8, further including:

a processor (80' ) which receives signals from the temperature sensor (90, 92) and flow sensor system (60' ) and determines an indication of thermal loading or remaining thermal capacity of the cooling system.

10. The assembly of claim 9, wherein the processor (80' ) determines a cooling period, based on the determined indication, x-ray tube power, operating time, and duty cycle of a planned scan protocol to ensure that the x-ray tube is capable of performing the planned protocol without overheating.

11. A CT-scanner (100) including the assembly of **claim 1**.

12. A CT-scanner (100) comprising:

the assembly of **claim 1**;

an x-ray detector;  
a scan processor; and  
a display.

13. A method for controlling operation of an x-ray tube **(1)**, the method comprising:

circulating a cooling fluid through a housing **(30)**  
and over the x-ray tube with a pump **(40)**;

removing heat from the cooling fluid which has  
circulated through the housing; and

determining a flow rate of the cooling fluid,  
including:

determining a pressure difference across  
the pump or a function which correlates with the  
pressure difference, and

determining the flow rate from the pressure  
difference or function.

14. The method of claim 13, further including:  
in the event that the flow rate drops below a  
predetermined minimum value, reducing power to the x-ray tube.

15. The method of claim 13, further including:  
determining a temperature of the cooling fluid.

16. The method of claim 15, further including:  
determining a temperature difference.

17. The method of claim 15, further including:  
determining a thermal loading condition of the x-ray  
tube from the determined temperature and flow rate.

18. The method of claim 17, further including:  
in response to the determined thermal loading  
condition, controlling at least one of:

operating power of the x-ray tube;  
operating time of the x-ray tube;

selectable scan protocols; and,  
a cooling time prior to subsequent operating of the  
x-ray tube.

19. A system for removing heat from an associated x-ray tube **(1)** comprising:

a fluid flow path **(33, 33')** which carries a cooling fluid to at least a portion of the associated x-ray tube, and removes heat therefrom;

a pump **(40, 40')** which circulates the cooling fluid through the fluid flow path;

means **(52, 52')** for determining a pressure difference across the pump; and

means **(81, 81' , 82, 82' , 107)** responsive to the determined pressure difference for controlling operation of the x-ray tube.

20. The system of claim 19, wherein the determining means **(52, 52')** includes:

a means **(60, 60')** for measuring a pressure difference across the pump **(40, 40')**; and

a means **(80, 80')** for determining cooling fluid flow rate from the determined pressure difference.

21. The system of claim 20, further including:

means **(90, 92)** for determining a temperature of the cooling fluid; and

the means **(81' , 82)** for controlling also being responsive to the determined temperature.

22. The system of claim 21, further including:

a means **(120)** for selecting a scan protocol;

a means **(107)** for implementing a scan with the selected scan protocol;

the controlling means **(81, 81' , 82, 82')** in accordance with the determining flow rate and temperature controls at least one of:

operating power of the x-ray tube;  
operating time of the x-ray tube; and  
selectable scan protocols.